Back-to-Basics

A practical look at axial thrust position monitoring

Axial thrust position monitoring on turbomachinery is one of a machine's most important protective systems. Though other machine malfunction modes can be equally catastrophic, the deterioration and failure of a thrust bearing can occur with very little warning and in an extremely short period of time, leading to total destruction of the machine. Hence, safety, cost and lost production time all must be considered. Fortunately, the measurement technique required to provide this protection is straightforward and reliable if the instrumentation is installed properly.

Installation considerations and practices

Bently Nevada probes are designed to accept normal field treatment but reasonable care must be taken in handling and installing them. The following installation recommendations have been developed from extensive experience with probe installations:

Two axial position probes should be used, with each one mounted within 12 inches (300 mm) of the thrust bearing observing an intergral part of the rotor. When probes are mounted further away, thermal growth or other changes not related to axial position may give misleading information on the axial position of the shaft. Should an axial position probe be mounted at the opposite end of the rotor from the thrust bearing, for example, position changes can occur that are unrelated to thrust.

Before installing a probe, the tapped hole should be free of foreign material, and the threads should be both clean and in good condition. Because the probe "sees" to the side, there should be no metal within approximately 1/2 X - 1X the tip diameter of the probe face (depending on the probe type), except the observed surface. Counterboring, chamfering or other relieving may be necessary to achieve proper lateral clearance for the probe tip.

The probe should be threaded into its mounting until the desired gap (i.e., center of the available linear range of the transducer) between the probe and observed surface is obtained. The gap can be measured mechanically with a feeler gauge. It can also be measured more accurately electrically by connecting the probe to an extension cable and Proximitor® and then observing the indicated transducer output voltage.

Axial position probes should be gapped when the machine is not running, so the rotor can be placed at a known position with respect to the clearances in the thrust bearing. Ideally, the center of the transducer's linear range should correspond to the center of the rotor's float zone (either cold or hot; both have the same center). However, it is difficult to position and hold a rotor at the exact center of its float zone. A much easier technique is to position the rotor (thrust collar) at one side or the other (typically the active side) of the thrust bearing and then install the probe at the proper gap distance/voltage.

Each machine configuration will usually dictate that one particular thrust probe installation system is more desirable than the other possible systems (i.e., internal mounting versus external mounting). Regardless of the system choice, the installation hardware must allow proper probe location.

Special considerations: external probe mounting

It is usually advantageous to mount the probe through the machine case using a standard probe mounting assembly adapted to the machine. Brackets may be designed for external probe mounting when it is impossible or undesirable to mount the probe through the case in this manner. However, the bracket must be rigid enough so that it will not vibrate.

Armor cabling is available for the probe leads and extension cables. All exposed cables and leads should be armored or otherwise protected by conduit. The armoring will not seal out water, oil or gases, but it is highly effective against physical damage to the cable.

Special considerations: internal probe mounting

Though it is always advantageous to mount probes on rigid brackets or through the machine case, probes can be internally mounted. In doing so, care must be taken to ensure that the probe is mounted solidly and the proper gap is set. After the probe is mounted, it is ►

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difficult to make adjustments without dismantling the machine. The probe leads must be long enough to avoid having connectors inside the machine. This provides easy access to install the extension cable and provides a point for connection of test equipment should system troubleshooting be necessary.

Inside the machine, the probe lead must be secured to prevent it from whipping around. Cable brackets holding the leads to the side or end of the machine case are required. Internally mounted probes require an exit through the machine case for the probe leads. Oil leaks must be prevented around the exit point. Whenever probe-to-Proximitor® extension cables must pass through machine cases with pressure differentials as high as 1000 psi, high pressure feedthroughs should be used. *NOTE: Cable seals (i.e., gland seals) and high pressure feedthroughs are not the same. Cable seals are not pressure rated.*

After the probe lead is attached to the extension cable for the final time, a Connector Protector should be installed. The connectors can also be wrapped with Teflon® tape, covered with a shrinkable tubing or encapsulated with RTV or similar sealant that does not have an acetic acid base.

Additional considerations, with respect to the thrust probes and related hardware, include:

1. The probe(s) must observe an integral probe surface that is perpendicular to the rotor axis and has a width equal to or greater than 2X the probe tip diameter.
2. Probes must be referenced to the bearing assembly rather than an end bell or other element that may experience thermal growth during operation.

Dual-voting axial probes

It is recommended that two axial probes be used in a **dual-voting** arrangement to add redundancy and minimize the possibility of false alarms. American Petroleum Institute (API) 670 recommendations dictate that the best transducer locations observe the end of the shaft as shown in Figure 1. It is acceptable to use the standard optional arrangement shown in Figure 2, with one probe observing the end of the shaft and the other observing an integral collar. It is important that the collar be integral; should a nonintegral thrust collar become loose on the rotor, the axial probe observing the collar can no longer measure true rotor movement. Monitoring requirements for most turbines dictate that the probe be placed on the steam inlet shaft end, inboard or outboard of the thrust collar.

Rotor axial position versus meter reading

After establishing the correct relationship between the probe gap and the thrust collar position within the bearing, the third variable in the system to address is that of meter reading. After all, a control room operator does not see the actual rotor position in the bearing, nor the probe gap voltage directly. The operator's interface to the measurement system is the meter readout. It is therefore necessary to correctly relate the probe gap voltage/thrust collar position to the meter.

It is important to note that when calibration over the full display range of a 40-0-40 mil monitor is required, using a Proximitor® with 80 mils range, the display zero can only be set at the center of the transducer range. Zero adjustment must be done by changing probe gap. This is why the zero adjustment range on thrust position monitors is very limited. Failure to do this can result in loss of machine protection as the transducer signal may not be able to reach a preset danger setpoint. If you have any questions, contact a Bently Nevada sales or service representative.

Most manufacturers' thrust position monitors typically display shaft axial position (displacement) under normal monitor operation. Bently Nevada thrust position monitors display in this manner as well but additionally will allow the operator to read probe gap voltage by actuating a front panel switch.

Proper monitor system setup includes calibration. Proper calibration ensures that a measured change in probe gap voltage and a corresponding change in the displacement reading on the thrust monitor accurately represent a known change in rotor axial displacement.

Alarming

It is important to note that most machines allow significant axial movement of the rotor before an axial rub between rotor and stator occurs. When considering thrust position alarm setpoints, recognize that the objective of thrust monitoring is not necessarily to save the thrust bearing completely from damage. The primary objective is to prevent severe axial rubs and machine destruction. In effect, some thrust bearing wear is acceptable under most operating conditions. Thrust bearings typically have enough babbitt (white metal) to sustain babbitt loss long before the rotor is in danger of an axial rub (this can be tested by carefully measuring the travel of the rotor without the thrust bearings installed). Therefore, it is recommended to allow for some babbitt loss to occur before reaching the first alarm setpoint.

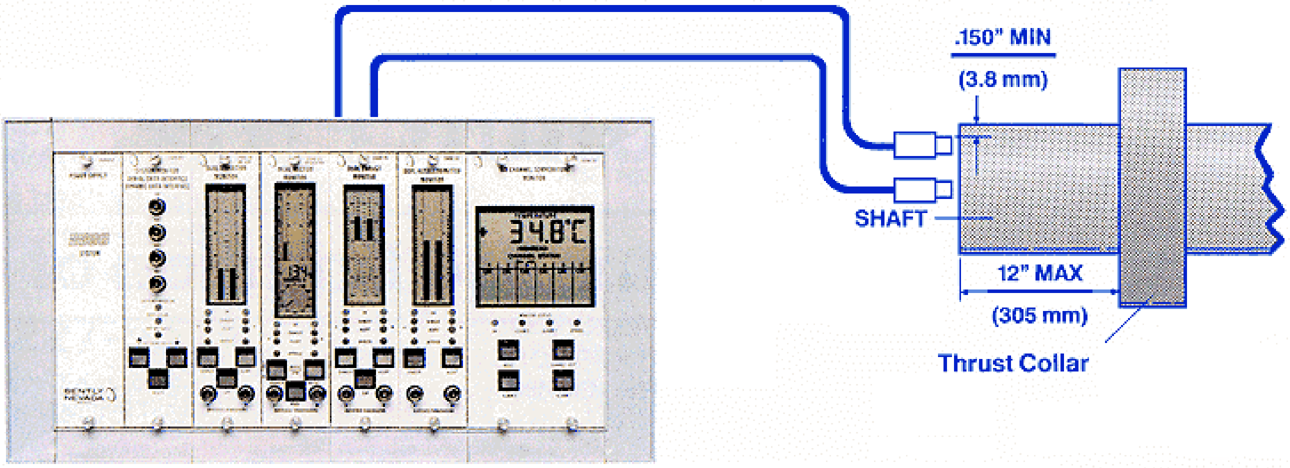

Figure 1
Axial thrust probe mounting location recommended by API 670

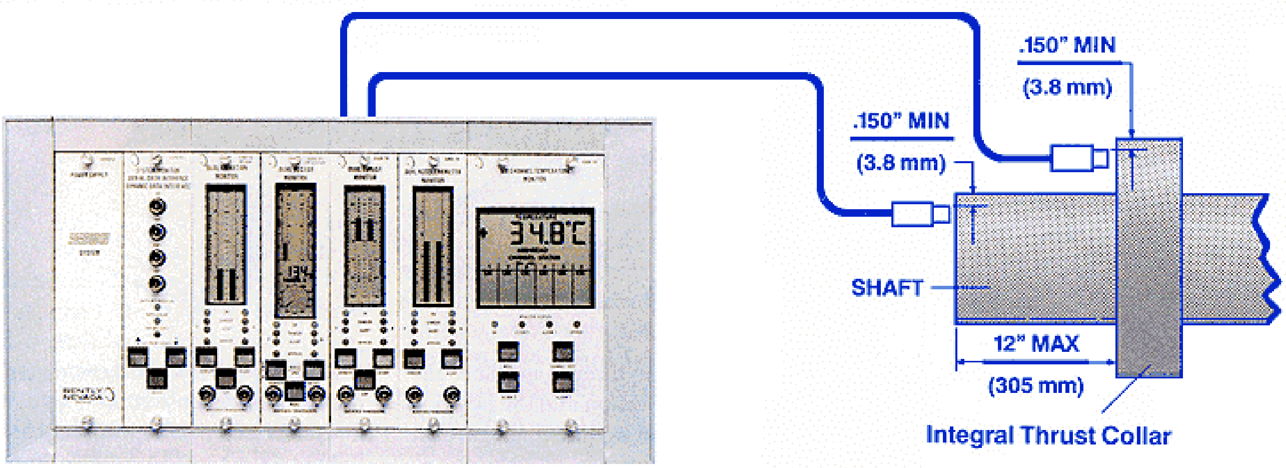

Figure 2
Alternative axial thrust probe mounting location

With most monitoring systems, there are four alarm setpoints: first and second level alarms in each of the active/normal and inactive/counter bearing directions. The first level (Alert) alarms should be set beyond the limit of the hot float zone in each direction so some babbitt will be removed before the alarm actuates. The second level alarm (Danger) should be set to actuate after even more babbitt loss but well before the rotor is in danger of an axial rub or wearing through the babbitt and damaging the thrust collar.

3300/20 Dual Thrust Position Monitor

Bently Nevada's 3300/20 Monitor provides early warning of thrust bearing failure which can lead to extensive machine damage. While accepting inputs from two proximity probe transducer systems, it continuously measures and monitors two independent channels of axial shaft position within the machine. To provide transducer redundancy and added security against false alarms, the monitor offers AND voting logic between the two independent transducer channels. Quality, reliability and user-friendly features make this monitor a critical part of an effective thrust position monitoring system.